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Rural ITS Progress Study – Arizona 2004

Over the past decade, the Arizona Department of Transportation (ADOT) has deployed Intelligent Transportation Systems (ITS) in mainstream rural highway operations. Variable Message Signs (VMS), Road Weather Information Systems (RWIS), and remote cameras have become indispensable, standard equipment for many of ADOT's rural districts. Growing dependence on the rural ITS infrastructure (ITI) has also increased demand on resources, including additional funds needed for operations and maintenance (O&M). This study evaluated the performance of 18 key elements of ADOT's rural ITI to help focus the Agency's resources on the most useful devices and systems.

Study Objectives

The objectives of this research were to:

- 1) Measure the performance and document the benefits of the deployed systems, and of ADOT's rural ITS program.
- 2) Identify and document current operating and maintenance costs and issues.
- 3) Determine travelers' perceptions and reactions to rural ITS elements.
- 4) Determine how well ADOT has adhered to the 1998 Statewide ITS Plan's vision.

Study Methodology and Findings

The key steps in this research included literature review, surveys of and interviews with agency users and the general public, ITS infrastructure

performance data collection, and information analysis. Information on previous deployment plans, typical and actual costs and benefits, relevant performance measures, and evaluation methodologies was sought by literature review.

The following key ADOT groups and partner stakeholders provided extensive feedback on usage, operations and maintenance issues; on performance, benefits and costs of deployed ITI; and on unmet rural ITS needs:

- 1) Technical Advisory Committee (TAC)
- 2) All ADOT Maintenance Districts
- 3) ADOT Transportation Technology Group (TTG)
- 4) Regional Traffic Engineering Offices (RTEOs)
- 5) ADOT Information Technology Group (ITG)
- 6) ADOT Motor Vehicle Division (MVD)
- 7) ADOT Equipment Services Group
- 8) Arizona Department of Public Safety (DPS)
- 9) National Weather Service (NWS)
- 10) Neighboring state Departments of Transportation (DOTs)
- 11) ITS Equipment vendors and consultants
- 12) Commercial vehicle operators (CVO)
- 13) The general public (via surveys)

Study conclusions and recommendations were derived with significant input from project TAC members. The following table highlights the key findings for each of the 18 ITS elements studied:

	ITS Element	Outputs	Outcomes/Benefits	Costs
Surveillance and Data Collection Systems	Road Weather Information Systems (RWIS)	Wind, temperature, precipitation, chemical	Plowing & deicing operations; dust storm prediction/warning; additional data for National Weather Service (NWS); traveler safety	Capital cost - \$137,200-145,200 per site; annual operating & maintenance (O&M) costs - \$170/\$3,328 per site
	Passive Acoustic Detectors (PAD)	Speed, volume, occupancy	Supplement automatic traffic recorder data; improves employee safety	Integral part of RWIS stations; about \$2,500 per unit.
	Remote Cameras (CCTV)	Camera images (still frame)	Verify current weather and pavement conditions; public can access images	Capital cost to install 2 cameras at existing VMS site: \$20,000
	Speed Detection/Warning Devices	Speed warning messages	Reduced 85 th percentile speed 18%; improved safety/reduced repair costs	Capital cost for pilot installation on existing structure - \$48,820
	License Plate Readers	License plate matches (11%-data from 2001)	96% of incentive was collected; improved level of service/reduced delay	Incentive to maintain travel time: <1% of project cost
Information Fusion and Dissemination Systems	Highway Condition Reporting System (HCRS)	Traveler information entries (12,450/year – data from 2000 2002)	Improved project and emergency communications; traveler information is quickly available to the public	\$270,000 to develop HCRS; \$62,000/yr for data entry labor; monthly maintenance costs
	Traveler Information via Telephone (511)	About 344,000 calls / year (data from 2003)	Less demand on public agency staff for information; public relations; better travel decisions; easy to remember	\$270,000 to develop voice interface; \$85,000-system upgrades; \$137,000/yr O&M; promotion
	Traveler Information via Internet: www.az511.com	75 million hits/yr; 10 million page views/yr (data from 2003)	Less demand on public agency staff for information; public relations; better travel decisions; restrictions data access.	System hardware/software development & maintenance costs; promotion costs
	Overhead Variable Message Signs (VMS)	About 8,800 messages/year (data from 2003)	Less demand on public agency staff for information and congestion management; better travel decisions	Capital costs - \$385,000; O&M costs - \$1,035/\$2,478/year
	Shoulder-Mounted VMS	Speed warnings; steep grades ahead/HAR frequency messages	Safety improvements; lower infrastructure repair costs	Installation - approx. \$70,000 per sign; O&M costs – under \$1,000/yr (estimated)
	Portable Trailer-Mounted VMS	Many deployments/year	Deployment flexibility; ease of set up; better travel decisions.	Solar \$925/mo.; diesel \$450/mo (Equipment Services rates)
	Highway Advisory Radio (HAR)	HAR messages (broadcast as needed or continually)	Effective part of public outreach program for construction projects; better travel decisions.	Typical turnkey cost \$1,900/month (includes licensing, setup, maintenance, removal)
Commercial Vehicle Electronic Clearance	Portable Traffic Signals	Traffic signal indications	As flagger replacement, reduces labor costs, improves safety (more visible).	About \$70,000 to purchase; rental \$200 to \$300/day
	Commercial Vehicle Electronic Clearance (PrePass)	85% of trucks bypass during times ports are open (data from Aug. 2004)	Improve business environment by port automation; improve compliance/enforcement; more economic delivery of goods; fuel savings; reduce truck wear and tear; improve on-time service	Equipment installation free; labor costs for creating software/database links - minimal. PrePass funded by others.
	Expedited Processing at International Crossings (EPIC)	Average queue wait time	Improved port throughput and compliance verification; increased security, efficiency, traffic management; public access to queue wait time information	Construction costs: about \$700,000; Systems integration: \$275,000; Annual O&M costs \$30,000.
Emergency Detection and Response Systems	Instrumented Truck Escape Ramps	Intrusions detected: 37/ramp/yr (data: Jan-Sep 2004)	Improved agency coordination; improved safety; improved emergency response and ramp repair time	\$227,350-design/instrument two ramps; \$16,200/yr/ramp for O&M
	Emergency Roadside Callboxes	153/yr/callbox; calls requesting services: 18% (data from July 2003-June 2004)	Improved incident response time; identification of call location; increases public sense of safety; booster antennas increase cellular communications range	US 93: \$6,845/site to install (low; other costs absorbed by concurrent project); \$1,720/yr/site for O&M
	Rural Nighttime Motorist Assist Patrols (MAPs)	124 assists/year (data from 2001-2003)	Public relations; quickly assess needs; relieve Department of Public Safety resources; improved incident response time/safety; accident prevention	Bid item on current US 93 project represents less than one-half percent of total project cost - \$150,000 for 30 month project

Study Conclusions

Operating/Maintenance Costs and Issues:

A substantial O&M funding commitment to deployed ITS elements is required. Failure to maintain equipment causes negative perceptions of ITS among the driving public and can create liability issues for ADOT.

The practice of requiring ADOT's Regional Traffic sections to provide maintenance for RWIS and VMS has drawbacks (insufficient funding, training, parts inventory, manpower). Some equipment vendors may not always provide the expected level of support, or may do so at a high price. ADOT recently outsourced maintenance of RWIS and VMS in an attempt to cut costs and reduce downtime. The outsourcing strategy may prove beneficial to other rural ITI.

Traveler Perceptions and Reactions:

- HCRS informs az511.com and 511, which with VMS and HAR rank highest as traveler information sources with both the general public and CVO, based on awareness and use frequency. The same ranking holds for their perceptions of these systems' contributions to safety, mobility and cost savings.
- A majority of CVO respondents were aware of PrePass and instrumented truck escape ramps; these systems are perceived as contributing to safety and cost savings.
- The driving public is generally aware of emergency roadside callboxes, but the nighttime Motorist Assist Patrols on US 93 are not as widely known. However, most drivers perceive both services as contributing to travel safety.

ADOT Adherence to the 1998 Statewide ITS Strategic Plan's Vision:

ADOT's 1998 vision for the statewide rural ITS program was: "To have new, innovative ITS technologies operational statewide, providing a safer and more efficient intermodal transportation system, meeting the short and long-term needs of visitors, local communities, commercial operators, and the traveling public."

Since the late 1990's, ADOT has led the nation in HCRS and 511 innovation. Kingman District

in particular has demonstrated creative ways both to secure funding for ITI, and to maximize the utility of available technology by deploying combinations of devices. Examples include the use of shoulder-mounted VMS for advance notification of active HAR as well as for speed detection and driver warning, or the well-utilized instrumented truck escape ramps. The District is also leading the way with their deployment of emergency roadside callboxes on remote highways, and with motorist assist patrols.

Performance and Benefits:

Over the last decade, ADOT has deployed and now operates rural ITI across the state. These systems and devices are widely perceived to enhance the safety and efficiency of rural travel; they contribute to mobility and cost reduction. The Department has steadily improved system reliability and usefulness. Further actions that ADOT can take include:

- Deploy more RWIS, remote cameras and VMS statewide. These systems have a strong positive impact and are in high demand within the rural districts. Improve communications with remote devices, and sensor reliability.
- 511 and www.az511.com – improve voice recognition, and navigation in telephone menus; improve web content presentation, accuracy, timeliness, and provide for low-bandwidth access; continue promoting both systems to broaden user base.
- Proven benefits of shoulder-mounted VMS, HAR, emergency roadside callboxes, and Motorist Assist Patrols warrant consideration for expanded use. Consider wider use of the less popular but beneficial speed detection and warning devices, license plate readers, and instrumented truck escape ramps.
- Improve quality of Highway Advisory Radio content and reception.
- Improve PrePass compliance by CVOs.
- Reduce hang-ups, increase proper usage, and expand coverage of emergency roadside callboxes.

Overall, ADOT is following the ITS Plan, which addresses both short and long-term deployment horizons. The continued deployments of rural ITS in Arizona benefit all of the target user groups identified in the statewide ITS vision.

Study Recommendations

General:

1. Review ITS project prioritizing methods. Consider application of performance measures and monetary quantification of benefits.
2. Update the Statewide ITS Plan; prioritize new construction and features; account for technology changes, funding constraints, system goals, need priorities, and usage experience.
3. Incorporate ITS into driver education (e.g. outreach programs to introduce children to ITS)
4. Create opportunities for Districts to share practical rural ITS ideas and experiences.

Surveillance and Data Collection Systems:

1. Upgrade RWIS communications to digital cellular, satellite, or radio. Consider other data sources (NWS, airports, observers). Provide bucket-truck-ready pullouts at pole-mount sites or use truss towers. Upgrade RWIS software.
2. Consider PAD or other non-intrusive technology for conducting traffic counts.
3. Consider using speed detection/warning devices on curvy mountain roads and at transitions from higher to lower speed limits.
4. Consider license plate readers for travel time estimation on projects with long detours, high business impact, or high road user costs.

Information Fusion and Dissemination Systems:

1. Upgrade HCRS program to allow verification of 511 audio, and to interface with HAR.
2. Expand 511 marketing, improve voice recognition, and provide more user-friendly menu options.
3. Offer www.az511.com data in low-bandwidth format, and list HCRS events automatically.
4. Strive for data quality and completeness.
5. Provide traveler information customization by route and delivery system (511, az511.com website, email and pagers.)
6. Consider improved Regional Traffic program funding and training, or a specialized

statewide team for VMS maintenance; add sign catwalk extensions to prevent lane closures.

7. Consider HAR for construction project outreach, based on factors of broadcast quality, communications links, update frequency, and mode of operation (continuous broadcast versus only when a new message is needed). Consider HAR applications at the Mexican border.

Traffic Control / Commercial Vehicle Electronic Clearance Systems:

1. Consider hard-wired power or backup power supply for portable traffic signals. For one-lane section control, consider signals vs. flaggers, based on costs, visibility, high-profile vehicles, driver expectations and DPS support. Consider portable or temporary signals for the short-term replacement of damaged permanent signals, based on use time and cost factors.
2. Train port of entry staff on reporting PrePass violations. Install mainline weigh-in-motion at all PrePass-equipped ports of entry.

Emergency Detection and Response Systems:

1. For instrumented truck escape ramps, review captured incident images to identify high-risk trucks/companies to be targeted in outreach efforts. Consider instrumenting additional ramps in Arizona, based upon ramp location, accident experience, traffic level, availability of communications, and level of roadway use by high-risk trucks/companies.
2. If expanding emergency roadside callbox coverage, consider accident experience, traffic levels, DPS coordination, ADA (Americans with Disabilities Act) compliance, communications, and system self-diagnostics as factors.
3. Consider expanding the coverage area of Motorist Assist Patrols, with accident experience and traffic levels as factors. Consider making MAP operators state employees. Consult existing operators to help specify vehicle requirements, equipment lists and job requirements, and to train new operators.

The full report: *Rural ITS Progress Study—Arizona 2004* by Michael Wendtland, Andrew Kolcz and Ryan Christenson of ITS Engineers (Arizona Department of Transportation, report number FHWA-AZ-04-570, published February 2005) is available on the Internet. Educational and governmental agencies may order print copies from the Arizona Transportation Research Center, 206 S. 17 Ave., MD 075R, Phoenix, AZ 85007; FAX 602-712-3400. Businesses may order copies through ADOT's Engineering Records Section.